

IN THE CLAIMS

1. Apparatus for conditioning an edge of a stack of sheets to be bound comprising:
 - 5 a stack clamping mechanism configured to secure the stack of sheets;
 - a piercing member configured to produce a piercing action substantially in a piercing plane;
 - a positioning mechanism configured to control a relative movement of the stack clamping mechanism and the piercing mechanism so that the sheets
 - 10 of the stack pass through the piercing plane; and
 - a drive mechanism configured to drive the piercing member into the edge of the stack at least once for each sheet of the stack passing through the piercing plane.
- 15 2. The apparatus of Claim 1 wherein the sheets of the stack of sheets define a sheet plane in a region near the edge of the stack and wherein the positioning mechanism causes the sheet planes to substantially coincide with the piercing plane when stack passes through the piercing plane.
- 20 3. The apparatus of Claim 2 wherein the sheets of the stack each have an approximate thickness of N units and wherein the drive mechanism is configured to drive the piercing member into the stack at least once for every N units of relative movement of the stack and piercing blade.
- 25 4. The apparatus of Claim 2 wherein the drive mechanism is configured to drive the piercing mechanism into the stack approximately twice every N units of the relative movement.
- 30 5. The apparatus of Claim 1 wherein the piercing member includes a plurality of separate piercing elements, with each of the piercing elements having a cutting edge.

6. The apparatus of Claim 5 wherein the drive mechanism further includes a support member, said support member being pivotally mounted at a first location on the support member and with said support member securing the piercing member at a second location spaced apart from the first location, with
5 said support member being pivoted about the first location so that the piercing member is moved between a withdrawn position and a piercing position.

7. The apparatus of Claim 6 wherein the stack clamping mechanism is configured to secure the stack of sheets so that the edge of the stack is
10 positioned along a support plane, with the piercing member being disposed on one side of the support plane in the withdrawn position and with the piercing member extending past the support plane at least a distance of 0.01 inches into another side of the support plane in the piercing position.

15 8. The apparatus of Claim 5 further including a multiplicity of said piercing members, with the piercing action of each of the piercing members being substantially in the piercing plane.

9. The support member of Claim 8 wherein the drive mechanism further
20 includes a support member associated with each of the piercing members, each of said support members being pivotally mounted at a first location on the support member and with said support member securing the associated piercing member at a second location spaced apart from the first location, with said support members being pivoted about the first location so that the
25 associated piercing member is moved between a withdrawn position and a piercing position.

10. The apparatus of Claim 9 wherein the stack clamping mechanism is configured to secure the stack of sheets so that the edge of the stack is
30 positioned along a support plane, with the piercing members being disposed on one side of the support plane in the withdrawn position and with the piercing

members extending past the support plane at least a distance ranging of 0.01 inches into another side of the support plane in the piercing position.

11. The apparatus of Claim 10 wherein the drive mechanism is configured to drive each of the piercing members to the piercing position at a differing point in time.

12. The apparatus of Claim 11 wherein the drive mechanism includes a camshaft having a separate cam surface associated with each of the support members, with the cam surfaces engaging associated cam follower bearings mounted on the support members.

13. The apparatus of Claim 11 wherein the drive mechanism includes a drive shaft and a converting mechanism for converting a rotational motion of the drive shaft into reciprocating motion to drive each of the support members.

14. The apparatus of Claim 13 wherein the drive mechanism includes a crank assembly driven by the drive shaft and a connection assembly associated with each of the support members connecting the crank assembly and the associated support member.

15. The apparatus of Claim 1 wherein the piercing member includes at least one ceramic cutting element.

16. The apparatus of Claim 15 wherein the piercing member includes a multiplicity of separate ones of the cutting elements.

17. Apparatus for conditioning an edge of a stack of sheet to be bound comprising:
a stack clamping mechanism configured to secure the stack of sheets, with at least a region of the sheets of the stack near the edge being parallel to a piercing plane;

a piercing member having including a piercing edge movable in the piercing plane;

a positioning mechanism configured to control relative movement of the stack clamping mechanism and the piercing member; and

5 a drive mechanism configure to cause the piercing edge to reciprocate between a withdrawn position displaced from the stack and a piercing position contacting the stack.

10 18. The apparatus of Claim 17 wherein the piercing edge includes ceramic.

19. The apparatus of Claim 17 wherein said piercing member includes a plurality of spaced apart piercing edges, with all of the piercing edges moveable in the piercing plane.

15 20. The apparatus of Claim 17 further including a plurality of the piercing members, with each of the piercing members including a multiplicity of the piercing edges, with the piercing edges movable in the piercing plane and wherein the driving mechanism is further configured to cause the piercing edges of the respective piercing member to be reciprocated at differing points
20 in time.

21. The apparatus of Claim 20 wherein the piercing edges include ceramic.

25 22. Apparatus for conditioning a stack of sheets to be bound comprising:
a stack clamping mechanism configured to secure the stack of sheets, with at least a region of the sheets of the stack near the edge defining sheet planes;

30 a piercing member having a piercing element movable in piercing plane;
a positioning mechanism configured to control relative movement of the stack clamping mechanism and the piercing plane so that the sheet planes of

each of the sheets sequentially pass through, and become momentarily, substantially coincident with, the piercing plane; and

a drive mechanism configured to cause the piercing element to repeatedly engage and disengage the stack edge during the relative moment.

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23. The apparatus of Claim 22 wherein the piercing member comprises a multiplicity of cutting edges that move substantially in the piecing plane.

24. The apparatus of Claim 23 further including a plurality of the piercing
10 members and wherein the drive mechanism is further configured to cause the respective piercing elements to engage and disengage the stack at differing points in time.

25. The apparatus of Claim 22 wherein the drive mechanism is configured to
15 engage the stack at least once for every sheet that passes through the piercing plane.

26. A method of conditioning an edge of a stack of sheets to be bound, said
20 method comprising:

providing a piercing member;

supporting the stack so that a compression force is applied to the stack in a region near the edge of the stack;

periodically driving the piercing member into the edge of the stack and
25 withdrawing the piercing element, with the direction of drive into the edge of the stack being within ± 25 degrees of a plane of the sheets of the stack in the region of the sheets near the edge of the stack; and

moving the piercing member and the stack relative to one another so that each sheet of the stack is pierced by piercing element.

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27. A stack of sheets conditioned in accordance with the method of Claim 26.

28. The method of Claim 26 wherein the piercing member includes a plurality of individual spaced apart piercing elements aligned along a common axis and wherein the periodically driving includes driving the piercing elements
5 into the edge of the stack with the common axis being substantially parallel with the edge of the stack.

29. A stack of sheets conditioned in accordance with the method of Claim
10 28.

30. Apparatus for conditioning an edge of a stack of sheets to be bound
comprising:

a stack clamping mechanism configured to secure the stack of sheets,
with a region of the sheets near the edge lying within individual sheet planes;
15 a piercing member configured to produce a piercing action in a piercing
direction;

a positioning mechanism configured to control a relative movement of
the stack clamping mechanism and the piercing member so that the sheet
planes are substantially parallel to the piercing direction; and

20 a drive mechanism configured to periodically drive the piercing member
into the edge of the stack and away from the edge of the stack.

31. The apparatus of Claim 30 wherein piercing member includes a
multiplicity of separate piercing elements and wherein said positioning
25 mechanism and said drive mechanism are configured so that each sheet of the
stack is pierced by at least one of the piercing elements.

32. The apparatus of Claim 30 where the positioning mechanism operates
such that a longitudinal axis of the edge is generally orthogonal to a first axis
30 and wherein the piercing member includes an array of separate piercing
elements, with a number and lateral spacing of the piercing elements with
respect to the first axis being such that each sheet of the stack is pierced by at

least one of the piercing elements when the relative movement is along the longitudinal axis.

33. The apparatus of Claim 32 wherein the piercing elements are disposed
5 along a first axis, with the first axis and the longitudinal axis being aligned with respect to one another at an acute angle.

34. The apparatus of Claim 33 wherein the acute angle is at least one
10 degree.

35. The apparatus of Claim 34 wherein the acute angle is less than 10
degrees.

36. The apparatus of Claim 33 further including a plurality of the piercing
15 members, with each of the piercing members including a plurality of separate piercing blades, with each of the piercing blades including a multiplicity of the piercing elements aligned along the piercing axis and wherein the drive mechanism is further configured to drive the piercing members at differing points in time.

20 37. Apparatus for conditioning an edge of a stack of sheets to be bound comprising:

a stack clamping mechanism configured to secure the stack of sheets,
with a region of the sheets near the edge lying within individual sheet planes;

25 a piercing mechanism including a plurality of piercing members, with each of the piercing members having a piercing edge aligned along a piercing axis, with each of the piercing edges movable piercing direction substantially parallel with the sheet planes;

a positioning mechanism configured to control a relative movement of
30 the stack clamping mechanism and the piercing mechanism so that a longitudinal axis of the edge of the stack is disposed at an acute angle with respect to a longitudinal axis of the edge of the stack; and

a drive mechanism configured to periodically drive the piercing members into the edge of the stack and away from the edge of the stack.

38. The apparatus of Claim 37 wherein the piercing members are positioned
5 along the piercing axis such that a spacing of the piercing members relative to an axis normal to the longitudinal axis is at least equal to a width of the sheets of the stack so that each sheet of the stack is pierced by at least one of the piercing members.

10 39. The apparatus of Claim 38 wherein the drive mechanism further includes a support member associated with each of the piercing members and wherein the drive mechanism is further configured to drive the piercing members in to the stack at differing points in time.

15 40. The apparatus of Claim 39 wherein the drive mechanism includes a drive shaft and reciprocating apparatus configured to convert rotational motion of the drive shaft to reciprocating motion.

20 41. The apparatus of Claim 40 wherein the reciprocating apparatus includes, for each of the support members, a cam surface and a cam follower engaging the cam surface.

25 42. The apparatus of Claim 40 wherein the reciprocating apparatus includes, for each of the support members a crank assembly and a connecting assembly.

43. A method of conditioning an edge of a stack of sheets to be bound, said method comprising;

providing an array of piercing members disposed along a first axis;
supporting the stack so that a compression force is applied to the stack
30 in a region near the edge of the stack;

periodically driving the piercing members into the edge of the stack, with the direction of drive being ± 25 degrees of a plane of the sheets of the stack in the region of the sheets near the edge of the stack; and

- moving the array of piercing members and the stack relative to one
5 another so that a longitudinal axis of the stack edge is at an acute angle with
respect to one another so that each sheet of the stack is pierced by the
piercing elements.

44. The method of Claim 43 wherein the acute angle is greater than 1
10 degree and less than 10 degrees.

45. A stack of sheets conditioned in accordance with Claim 44.